Earth Science Data Information System (ESDIS) Project Mission Specific Requirements for the Landsat 7 Mission Level 1 Processing

July 1997

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(ESDIS) Project
Mission Specific Requirements
for the
Landsat 7 Mission Level 1 Processing

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Preface

This document was developed to define the level 2 requirements for the Landsat 7 Mission Level 1 processing, to insure that all needed services are provided, to assist in the identification of lower level (level 3) requirements, and to facilitate the allocation of these requirements between the ESDIS Project and the Landsat 7 Project. A trace table in this document will identify traces to the ESDIS Level 2 requirements (which in turn trace to EOSDIS Level 3 system specifications), and to external Landsat 7 level 3 requirements documents.

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Abstract

This document provides a brief overview of the Landsat 7 Mission Level 1 processing within the context of the EGS and the Landsat 7 Ground System, and presents the mission specific level 2 requirements which are allocated to EOSDIS components and Landsat Ground System components. It includes all Landsat 7 Mission Level 1 processing requirements for which ESDIS has responsibility.

The EOSDIS is responsible for production and distribution of Landsat 7 Level 1 data products. The facilities will be located at the USGS EROS Data Center (EDC) in Sioux Falls, South Dakota, and will utilize the EOS Core System (ECS) components installed at the EDC DAAC, and the Landsat 7 Level 1 Product Generation System (LPGS) to perform the level 1 product ordering, accounting, billing, production, and distribution. The level 1 products will be produced on-demand, and distributed in formats developed by the Landsat 7 Project and the ESDIS Project.

This volume will trace to the applicable ESDIS Level 2 requirements documents and Landsat 7 level 3 requirements documents.

Keywords: *Landsat 7, ESDIS, EGS, EOSDIS, EOS, ECS, level 1, LPS, LPGS, L0R, L1R, L1G*

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Section 1.0 Introduction

1.1 Scope

Current ESDIS support for the Landsat 7 Mission is provided by ECS functionality resident at the EDC DAAC, and includes archival and distribution of Landsat 7 Enhanced Thematic Mapper Plus (ETM+) Level 0R (L0R) data including ingest, archival, search and order, billing and accounting, product distribution, and user services for Landsat 7 L0R products. Figure 1-1 depicts the Landsat 7 data flow through the EGS. The ESDIS Project has received funding and direction to add production Level 1 data processing capabilities to the Landsat 7 Ground System. A new system, the Landsat 7 Level 1 Product Generation System (LPGS) is being developed to satisfy this requirement. Certain level 1 processing requirements involving user interfaces and product ordering, distribution, and billing will continue to be performed by ECS functionality resident at the EDC DAAC. This document presents the requirements for Landsat 7 Level 1 processing, to insure that ESDIS support meets the needs of the Landsat 7 Project and that the EOSDIS works as an effective part of the Landsat 7 Ground System. The ESDIS Project has responsibility for development and maintenance of this mission specific requirements document.

1.2 Landsat 7 Level 1 Processing Overview

The Landsat 7 LPGS is being developed to satisfy the requirement to perform production level 1 data processing of Landsat 7 ETM+ data. The EOSDIS is responsible for the ordering and distribution of Landsat 7 Level 1 data products. The level 1 processing facilities will be located at the USGS EROS Data Center (EDC) in Sioux Falls, South Dakota, and will utilize the EOSDIS EOS Core System (ECS) components installed at the EDC DAAC, and the LPGS to perform the level 1 product ordering, accounting, billing, production, distribution, and user services. The level 1 products will be produced on-demand by the LPGS, and distributed by the EDC DAAC in a format developed by the Landsat 7 Project and the ESDIS Project.

Figure 1-2, the Landsat 7 Ground System, depicts the Landsat 7 data flow including the generation of level 1 data products. Users query the EDC DAAC to browse available L0R data and place orders for level 1 products. Directory and guide information is available from the EDC DAAC to help users find the data they need. The EDC DAAC provides information on product cost reflecting NOAA/NASA pricing policy which is based on the cost of fullfilling a user request. Users order either level 1 radiometrically corrected (L1R) products or systematic geometrically corrected (L1G) products. The end user products are L1R or L1G digital images packaged with their associated metadata file, calibration and correction files, and quality and accounting file.

After the user has identified the data of interest and placed an order for a level 1 product, the EDC DAAC logs the order and generates a level 1 product request which is sent to the LPGS. The user order and level 1 product request includes parameters to be used in the level 1 process such as selected scene or subinterval identifier, geographic area, World-wide Reference System (WRS) scene identifier, L1R or L1G product selection, coordinate reference system for map projection, nominal path or North-up orientation, grid cell size, output product format, resampling filter, and

selected band(s). The LPGS receives and stages the L1 product request, and sends an Acquire Request for the corresponding L0R data to the EDC DAAC. After acknowledging the Acquire Request, the EDC DAAC retrieves the requested L0R data from its Landsat 7 data archive, stages this data on ECS disk space, and this L0R data is pulled by the LPGS. The LPGS schedules and subsequently produces the L1 digital images. L1R images are radiometrically corrected and L1G images are radiometrically corrected and geometrically corrected. The LPGS performs systematic geometric correction on the L1R data using one of several available resampling methods. L1G digital images are generated in a coordinate reference system that is user selectable from a suite of standard map projections, and to a geodetic accuracy consistent with systematic correction. The L1R or L1G digital images are packaged with their associated metadata file, and calibration and correction files to create the end-user product and staged on LPGS disk space along with production status and accounting data. The EDC DAAC pulls the L1 data products, logs the production status, performs the necessary billing and accounting procedures, and stages the L1 data products for delivery to the requester.

A detailed description of level 1 processing can be found in the *ESDIS Level 1 Product Generation System (LPGS) Operations Concept*, 510-3OCD/0296, February 1997.

1.3 Document Format

Section 1 contains introductory information including a high-level Landsat 7 level 1 processing overview; Section 2 lists applicable documents. Section 3 presents the ESDIS level 2 requirements for Landsat 7 level 1 processing. Appendix A. presents requirements traceability to the ESDIS level 2 requirements and the LPGS F&PR Specification level 3 requirements.

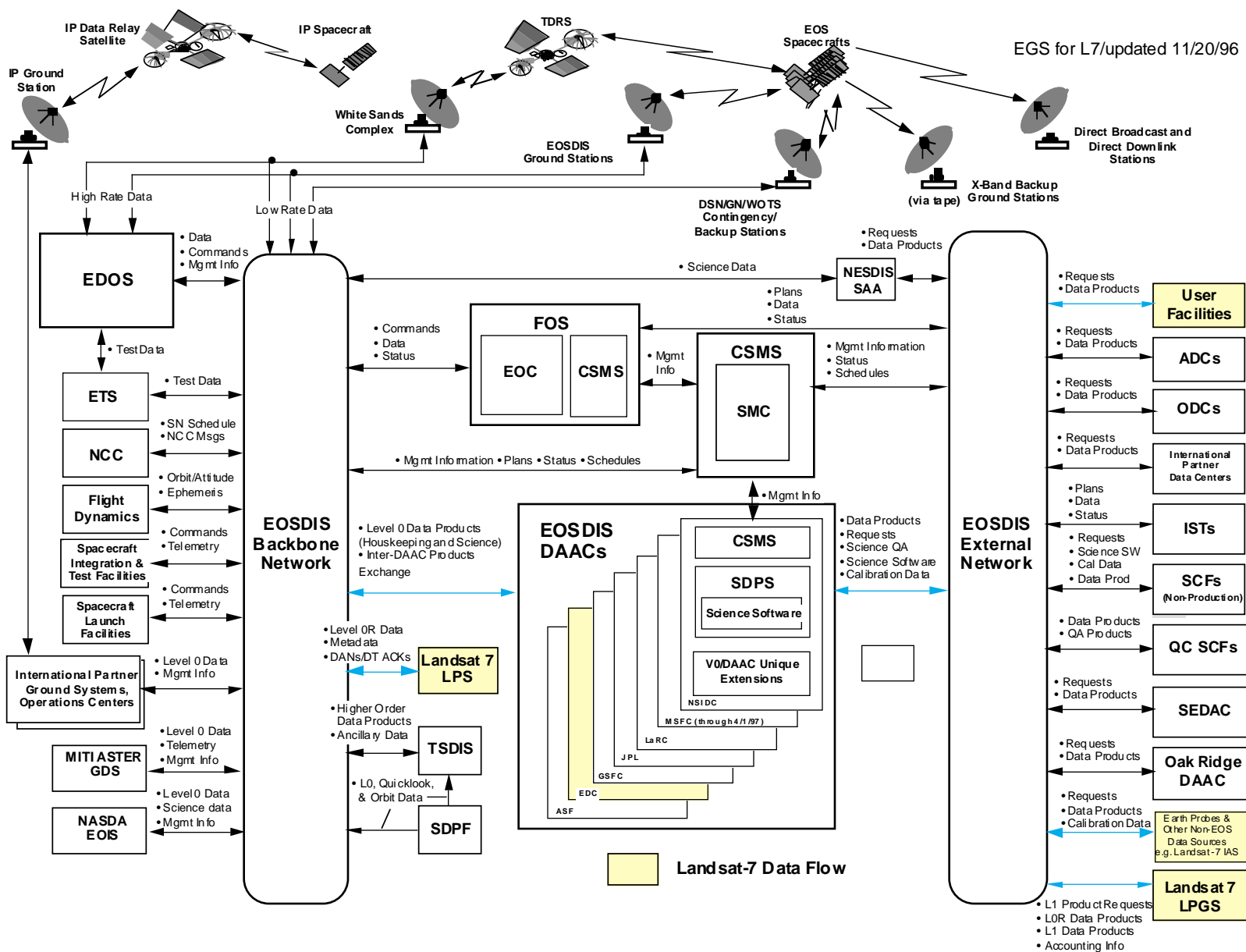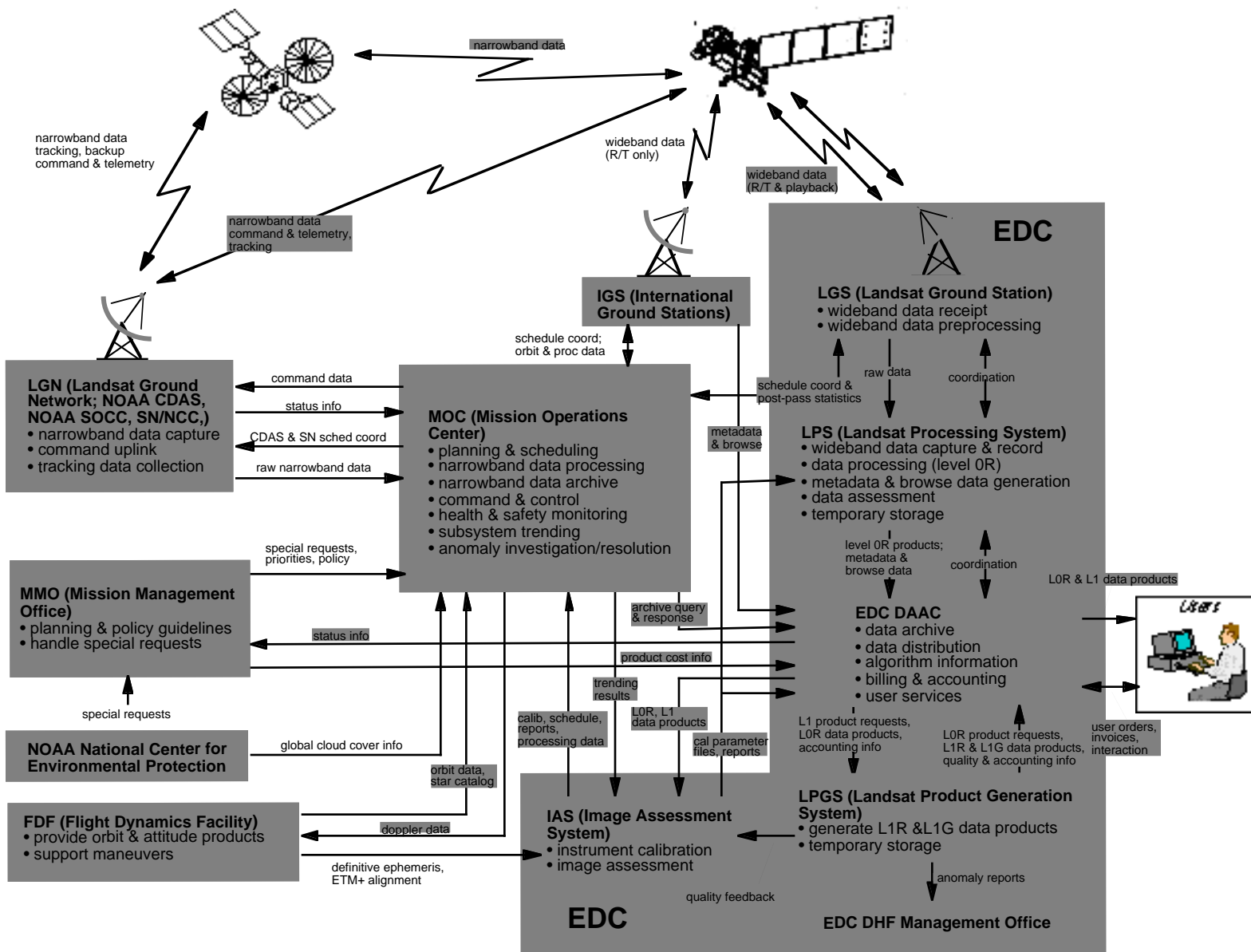**Figure 1-1. Landsat 7 Data Flow through the EGS**

EGS for L7/updated 11/20/96

Figure 1-2. Landsat 7 Ground System Diagram

narrowband data

narrowband data
tracking, backup
command & telemetry

wideband data
(R/T only)

wideband data
(R/T & playback)

narrowband data
command & telemetry,
tracking

EDC

**IGS (International
Ground Stations)**

LGS (Landsat Ground Station)
• wideband data receipt
• wideband data preprocessing

schedule coord;
orbit & proc data

schedule coord &
post-pass statistics

raw data

coordination

**LGN (Landsat Ground
Network; NOAA CDAS,
NOAA SOCC, SN/NCC,)**
• narrowband data capture
• command uplink
• tracking data collection

command data

status info

CDAS & SN sched coord

raw narrowband data

**MOC (Mission Operations
Center)**
• planning & scheduling
• narrowband data processing
• narrowband data archive
• command & control
• health & safety monitoring
• subsystem trending
• anomaly investigation/resolution

metadata
& browse

LPS (Landsat Processing System)
• wideband data capture & record
• data processing (level 0R)
• metadata & browse data generation
• data assessment
• temporary storage

level 0R products;
metadata &
browse data

coordination

L0R & L1 data products

**MMO (Mission Management
Office)**
• planning & policy guidelines
• handle special requests

special requests,
priorities, policy

status info

archive query
& response

product cost info

EDC DAAC
• data archive
• data distribution
• algorithm information
• billing & accounting
• user services

Users

special requests

trending
results

L0R, L1
data products

**NOAA National Center for
Environmental Protection**

global cloud cover info

calib, schedule,
reports,
processing data

cal parameter
files, reports

L1 product requests,
L0R data products,
accounting info

L0R product requests,
L1R & L1G data products,
quality & accounting info

user orders,
invoices,
interaction

orbit data,
star catalog

FDF (Flight Dynamics Facility)
• provide orbit & attitude products
• support maneuvers

doppler data

**IAS (Image Assessment
System)**
• instrument calibration
• image assessment

**LPGS (Landsat Product Generation
System)**
• generate L1R &L1G data products
• temporary storage

anomaly reports

definitive ephemeris,
ETM+ alignment

quality feedback

EDC DHF Management Office

EDC

Section 2.0 Applicable Documents

2.1 Source Document

[1] *Execution Phase Project Plan for Earth Observing System (EOS), Revision A,* NASA170-01-01, May 1995.

2.2 Reference Documents

[2] *Landsat 7 System Specification, Revision H,* GSFC 430-L-0002-H, June 1996.

[3] *Landsat 7 Processing System (LPS) Operations Concept Revision 2,* GSFC 560-3OCD/0194, April 15, 1995.

[4] *Landsat 7 0R Distribution Product, Draft Format Control Book HDF Version,* GSFC 430-11-06-007-0, December 28, 1996.

[5] *Landsat 7 level 1 Product Generation System (LPGS) Project Management Plan*, GSFC 510-xxxxxxxxx, May 1996.

[6] *EROS Data Center Operations Concept for the Landsat-7 Data Handling Facility,* Review Copy, May 1996.

[7] *Interface Requirements Document between the Earth Observing System Data and Information System (EOSDIS) and the Landsat 7 System,* GSFC 505-41-13, July 1995.

[8] *Interface Control Document Between EOSDIS Core System (ECS) and the Landsat 7 System,* Revision A, GSFC 423-41-39, May, 1997.

[9] *Earth Science Data Information System (ESDIS) Project Level 2 Requirements Volume 0, Overall ESDIS Project Requirements,* GSFC 423-10-01-0, February 18, 1993.

[10] *Earth Science Data Information System (ESDIS) Project Level 2 Requirements Volume 1, Earth Observing System (EOS) Data and Information System (EOSDIS) Revision A,* GSFC 423-10-01-1, August 1, 1996.

[11] *Earth Science Data Information System (ESDIS) Project Level 2 Requirements Volume 6, Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (Ebnet) Requirements,* GSFC 505-10-01-6, December 1996.

[12] *Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System,* GSFC 423-41-02, June 2, 1994.

[13] *Memorandum of Understanding from 923/Landsat Project Scientist to 423/ESDIS Project Manager Documenting Performance Requirements for the ESDIS LPGS,* May 28, 1997.

[14] *Earth Science Data and Information System (ESDIS) Level 1 Product Generation System (LPGS) Operations Concept, 510-3OCD/0296,* February 1997.

[15]   *Earth Science Data Information System (ESDIS) Level 1 Product Generation System (LPGS) Functional and Performance Requirements Specification, 510-FPD/0196, February 1997.*

Section 3.0 ESDIS Landsat 7 Level 1 Processing Requirements

3.1 Landsat 7 Level 1 Processing Requirements

This section contains the requirements on the ESDIS Project for Landsat 7 level 1 data processing.

3.1.1 General Requirements

a. The EOSDIS shall provide the capability to generate at least 25 level 1R or 1G equivalent WRS scene data products per day in any combination. — L7-0010

b. The Level 1R or 1G scene products generated by the EOSDIS shall be bound by the contents of the corresponding Level 0R scene product. — L7-0011

c. The EOSDIS shall accept user orders for level 1R or 1G data products. — L7-0015

d. The EOSDIS shall provide billing, accounting and collection services for the level 1R and 1G data products. — L7-0020

e. The EOSDIS shall store documentation (such as algorithm descriptions) and production process software for the level 1R and 1G production process. — L7-0025

f. The EOSDIS shall make documentation and production process software available to users on request. — L7-0030

g. The EOSDIS shall generate level 1 data products on demand based on submission of user orders. — L7-0035

h. The EOSDIS shall provide security according to the ESDIS security policy. — L7-0055

3.1.2 Data Processing Requirements

a. The EOSDIS shall provide the capability to compensate for systematically correctible artifacts during the production of the level 1R and level 1G digital image products. — L7-0100

b. The EOSDIS shall provide the capability to generate level 1 data products corresponding to either heritage world-wide reference system (WRS) scenes or to a partial ETM+ sub-interval up to an area equivalent to three WRS scenes. — L7-0105

c. The EOSDIS shall provide the capability to produce level 1G data products that are spatially continuous between contiguous partial sub-intervals or WRS scenes. — L7-0110

d.   The EOSDIS shall provide the capability to generate level 1G data products oriented to a nominal path or to North-up orientation.   L7-0130

e.   The EOSDIS shall provide the capability to generate level 1R or 1G data products with a variable grid cell size consistent with performance specifications provided by the Landsat 7 science office (see Reference [13]).   L7-0135

f.   The EOSDIS shall provide the capability to generate level 1R or 1G data products in coordinate reference systems for a minimum of seven (7) map projections.   L7-0140

g.   The EOSDIS shall provide the capability to generate and distribute level 1R or 1G data products in a minimum of three (3) output formats including HDF-EOS.   L7-0145

h.   The EOSDIS shall provide the capability to generate level 1G data products using a minimum of three (3) resampling methods as specified by the Landsat 7 science office (see Reference [13])   L7-0155

i.   The EOSDIS shall accept order cancellations on previously ordered Level 1R and 1G data products.   L7-0160

j.   The EOSDIS shall provide granule-level (individual scene or subinterval) status on level 1R and 1G data product orders to users.   L7-0165

k.   The EOSDIS shall accept feedback from users on the quality of level 1R and 1G data products.   L7-0170

l.   The EOSDIS shall provide cost estimation for level 1R and 1G data product orders.   L7-0175

m.   The EOSDIS shall generate level 1R data products consistent with performance specifications provided by the Landsat 7 science office (see Reference [13]).   L7-0180

n.   The EOSDIS shall generate level 1G data products consistent with performance specifications provided by the Landsat 7 science office (see Reference [13]).   L7-0185

o.   The EOSDIS shall assure quality of the level 1R and 1G data products consistent with performance specifications (see Reference [13]).   L7-0190

p.   The EOSDIS shall provide the capability to inspect, including visual inspection, each level 1 digital image for production quality.   L7-0191

q.   The EOSDIS shall collect performance and quality data on each level 1 digital image generated.   L7-0192

r.   The EOSDIS shall generate reports and metrics on level 1 data products produced.   L7-0193

s.   The EOSDIS shall provide the capability to produce partial scene L1R or L1G digital images corresponding to the smallest L0R product that can be ordered by a user.   L7-0194

3.1.3   Data Storage Requirements

a.   The EOSDIS shall provide the capability to store level 1R and Level 1G data   L7-0200
products for up to 72 hours.

b.   The EOSDIS shall provide the capability to allow the filling of an order for level 1R   L7-0210
or level 1G data products from data products resident in temporary storage.

3.1.4   Data Distribution Requirements

a.   The EOSDIS shall provide the capability to distribute at least 25 level 1R and level   L7-0300
1G equivalent WRS scene data products per day to the requesters.

b.   The EOSDIS shall package and deliver performance and quality data with each level   L7-0310
1R and 1G data product.

c.   The EOSDIS shall package with level 1R and 1G data products all related data   L7-0320
necessary to interpret those level 1R and 1G data products.

d.   The EOSDIS shall collect and send radiometric characterization data to the IAS.   L7-0321

3.1.5 Communications Requirements

a.   The EOSDIS shall provide networking and communications services in support of   L7-0400
level 1 processing.

3.1.6 Operations Requirements

a.   The EOSDIS shall provide the capability to reprocess up to 10% of a days data on a   L7-0500
daily basis.

b.   The EOSDIS shall monitor system performance and data quality.   L7-0530

c.   The EOSDIS shall provide user access to information management services for data   L7-0540
search, ordering, and order status.

d.   The EOSDIS shall provide level 1 processing for a minimum of five years.   L7-0545

e.   The EOSDIS shall provide the capability for expansion of the capabilities and   L7-0580
volume of the level 1 product generation functions.

3.1.7   Integration and Test Requirements

a.   The EOSDIS shall provide the capability to incorporate new algorithms and   L7-0630
software to improve the radiometric and geometric characteristics of level 1 data
products.

b. The EOSDIS shall be able to revalidate level 1 processing capabilities whenever an upgrade/enhancement is made. L7-0640

c. The EOSDIS shall maintain test data sets and be able to repeat tests to assure compliance with ESDIS Landsat 7 level 1 processing requirements. L7-0650

Appendix A. Requirements Traceability

MSRD Rqmt #	ESDIS Level 2 Rqmt #	LPGS F&PR Spec Level 3 Rqmt #
L7-0010		4.1.1
L7-0011		3.3.2, 3.3.3
L7-0015	210876, 210656, 211623, 211624	
L7-0020	210894, 210624	
L7-0025	210662	3.1.19
L7-0030	210439	
L7-0035		3.1.1
L7-0055		4.4.1
L7-0100		3.3.2.5, 3.3.2.6, 3.3.2.7, 3.3.2.8
L7-0105		3.1.21, 3.3.2.9, 3.3.2.10, 3.3.3.6, 3.3.3.7, 4.2.1
L7-0110		3.3.3.4
L7-0130		3.3.3.5
L7-0135		3.3.3.3
L7-0140		3.3.3.1
L7-0145	211464	3.3.6.1
L7-0155		3.3.3.2
L7-0160	210876, 211626	3.2.1, 3.3.8.7
L7-0165	211625	
L7-0170	210892	
L7-0175	210624	
L7-0180		4.1.2, 4.1.3, 4.1.8
L7-0185		4.1.2, 4.1.3, 4.1.8, 4.1.9

MSRD Rqmt #	ESDIS Level 2 Rqmt #	LPGS F&PR Spec Rqmt #
L7-0190		3.3.2.1, 3.3.2.2, 3.3.2.3, 3.3.2.4, 3.3.2.5, 3.3.2.6, 3.3.2.7, 3.3.2.8, 3.3.5.1, 3.3.5.2, 3.3.5.3, 3.3.5.4, 3.3.5.5, 3.1.15, 3.1.16, 3.1.17
L7-0191		3.3.5.1, 3.3.5.2, 3.3.5.3, 3.3.5.4, 3.3.5.5
L7-0192		3.3.3.8
L7-0193		3.3.4.1, 3.3.4.2
L7-0194	210876	3.1.21, 3.3.2.9, 3.3.2.10, 3.3.3.6, 3.3.3.7, 4.2.1
L7-0200	203266	3.3.7.1
L7-0210		3.3.7.2
L7-0300	203266	
L7-0310		3.3.4.3
L7-0320		3.3.4.3
L7-0321		3.2.3
L7-0400	EB2030, EB2130	
L7-0500		4.1.1
L7-0530	211243, 211339, 210894	3.3.8.1, 3.3.8.2, 3.3.8.3, 3.3.8.4, 3.3.8.5, 3.3.8.6, 3.3.8.8, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.3.6.3, 3.3.6.4
L7-0540	211393, 211344	
L7-0545		3.1.12
L7-0580		3.1.20
L7-0630		3.1.18
L7-0640		3.1.9, 3.1.13, 3.1.14
L7-0650		3.1.13, 3.1.14

Abbreviations and Acronyms

DAAC	Distributed Active Archive Center
DCN	Document Change Notice
EBnet	EOSDIS Backbone Network
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EGS	EOS Ground System
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
ESDIS	Earth Science Data Information System
ESN	EOSDIS Science Network
ETM+	Enhanced Thematic Mapper Plus (instrument)
ETS	EOSDIS Test System
FDF	Flight Dynamics Facility
GSFC	Goddard Space Flight Center
LAN	Local Area Network
LPS	LANDSAT Processing System
MTPE	Mission To Planet Earth
MTTRS	Mean Time To Restore Service
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications
NHB	NASA Handbook
NMI	NASA Management Instruction
NOAA	National Oceanic and Atmospheric Administration
NSI	NASA Science Internet
RMA	Reliability, Maintainability, and Availability
SMC	System Management Center
TBR	To Be Reviewed

WAN   Wide Area Network

WRS   World-wide Reference System

Glossary

FAST   FAST Argonne System for Transport; an output fomat for L1 digital images

GeoTIFF   Georeference Tagged Image File Format

HDF   Hierarchical Data Format

Level 1G Data Product: The end product distributed to the product requester. This product includes: the level 1G digital image and corresponding metedata.

Level 1G Digital Image: An image that has been radiometrically corrected and resampled for geometric correction and geographic registration.

Level 1R Data Product: The end product distributed to the product requester. This product includes: the level 1R digital image; metadata subinterval PCD data; mirror scan correction data (MSCD); internal calibrator data; and calibration parameter file.

Level 1R Digital Image: An image that has been radiometrically corrected but not geometrically resampled.

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